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SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

A136335

REPORT DOCUMENTATION PAGE

READ INSTRUCTIONS BEFORE COMPLETING FORM

1. REPORT NUMBER: TOP 3-2-045	2. GOVT ACCESSION NO.: AD-A136335
3. RECIPIENT'S CATALOG NUMBER:	
4. TITLE (and Subtitle): US ARMY TEST AND EVALUATION COMMAND TEST OPERATIONS PROCEDURE "AUTOMATIC WEAPONS, MACHINEGUNS, HAND AND SHOULDER WEAPONS"	5. TYPE OF REPORT & PERIOD COVERED: Final
	6. PERFORMING ORG. REPORT NUMBER:
7. AUTHOR(s):	8. CONTRACT OR GRANT NUMBER(s):
9. PERFORMING ORGANIZATION NAME AND ADDRESS: US ARMY ABERDEEN PROVING GROUND (STEAP-MT-M) ABERDEEN PROVING GROUND, MARYLAND 21005	10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS: DARCOM-R 310-6
11. CONTROLLING OFFICE NAME AND ADDRESS: US ARMY TEST AND EVALUATION COMMAND (DRSTE-AD-M) ABERDEEN PROVING GROUND, MARYLAND 21005	12. REPORT DATE: 21 December 1983
	13. NUMBER OF PAGES: 45
14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office)	15. SECURITY CLASS. (of this report): Unclassified
	15a. DECLASSIFICATION/DOWNGRADING SCHEDULE:

16. DISTRIBUTION STATEMENT (of this Report)

Approved for public release; distribution unlimited.

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES

DTIC ELECTE DEC 2 7 1983 S D H

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Automatic Weapons
Hand and Shoulder Weapons
Machineguns
Small Caliber Weapons
Weapons

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

This report describes procedures for testing automatic weapons, machineguns, hand and shoulder weapons to determine their conformance with requirements documents.

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US ARMY TEST AND EVALUATION COMMAND
TEST OPERATIONS PROCEDURE

DRSTE-RP-702-102
*Test Operations Procedure 3-2-045 21 December 1983
AD No.

AUTOMATIC WEAPONS, MACHINEGUNS, HAND AND SHOULDER WEAPONS

1. SCOPE. This TOP describes procedures for testing automatic weapons, machineguns, hand and shoulder weapons to determine their conformance with requirements documents.

*This TOP supersedes TOP 3-2-045 dated 30 June 1982.

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2. FACILITIES AND INSTRUMENTATION.

2.1 Facilities.

ITEM	REQUIREMENT
Test stands	
Ground mounts (bipods, tripods, gimbals, etc.)	
Control weapon	
Camera	35-mm with 80- to 200-mm zoom lens
Targets	Paper screen and/or plywood
Climatic chamber	To condition test item (-51° to 71° C)
Sand/dust chamber	To dispense mixture at rate of 100 ±25 g/min/m^2
Mud bath	Viscosity of 4,600 centipoises
Salt water solution	5% sodium chloride and 95% water
Ammunition guide tray	Low friction
Antisurge spring	Long enough to permit gradual load application
Gun solenoid	
Centrifuge facility	To accommodate weapon acceleration testing
Rain test facility	To provide water spray of 10 mm (0.4 in.) per minute

2.2 Instrumentation.

ITEM	MAXIMUM PERMISSIBLE ERROR OF MEASUREMENT*
Brookfield viscometer	±0.5% full-scale reading
Cyclic rate recorder	
Stargage and borescope	±0.025 mm
Oscillograph	
Thermograph/thermocouples	±0.6° C (1° F)

3. REQUIRED TEST CONDITIONS.

3.1 Planning.

a. Review the Safety Assessment Report and all instructional material issued with the test item by the developer, as well as reports of previous tests conducted on the same model or closely related item. Review the Interim Safety Release or Safety Release prepared by the testing agency.

b. Assemble information on the physical characteristics of the test item (TOP 3-2-500)[1]**, its method of operation, maintenance requirements, and expected modes and areas of deployment.

*Values can be assumed to represent ± 2 standard deviations; thus, the stated tolerances should not be exceeded in more than 1 measurement of 20.

**Footnote numbers correspond to reference numbers in Appendix B.

c. Based on the above information, plan a comprehensive testing program to verify that the test item satisfies minimum design and construction requirements for safe field deployment. Tests appropriate for forming a test program are described in paragraph 4. For some test programs, these procedures will need to be expanded or special test considerations will be required, while in other cases, not all procedures contained in this TOP will be applicable.

3.1.1 Sample Size. The number of weapons and rounds to fire per weapon must be considered in determining sample size. The number of weapons should adequately represent the population from which the sample has been drawn. If the sample is too small to sufficiently detect small differences in the statistical parameter(s) of interest, a conclusion regarding acceptability cannot be made with confidence. Although test economy must also be considered, the sample size must be sufficient to provide reasonable assurance that comparison of test results against requirements will be meaningful. TOP/MTP 3-1-002[2] provides guidance in selecting samples for desired levels of confidence in test results.

a. A subtest program for a hand or shoulder weapon should never be considered with less than three weapons. For complete engineering tests, 16 new weapons are considered satisfactory, with more than 4,000 rounds normally being fired from each weapon. To evaluate the weapon at or close to its expected serviceable life, 5,500 to 6,000 rounds (or as otherwise specified) should be fired from each of a sufficient number of weapons.

Whenever a certain minimum number of weapons is specified in this TOP, the number is considered adequate to detect fundamental and consistent weapon deficiencies in a particular environment. When marginal performance or randomly encountered problems are expected and are to be measured with some degree of confidence, more weapons must be used.

b. A subtest program for machineguns and automatic weapons should consist of at least three weapons; at least nine new weapons should be used for a complete engineering test. More than 22,000 rounds would be fired from each of these nine, and a sufficient number of these weapons would be fired (six may be fired 40,000+ rounds, of which three may be fired 50,000 rounds each) to evaluate the weapon at or close to its expected serviceable life. Additional testing for logistic supportability (maintenance evaluation) will be performed if needed (included in the previously mentioned weapon serviceable life evaluation). NOTE: External drive-type rotary weapons have much longer lives than gas-drive automatic weapons with single barrels. ROC requirements and statistical decisions should be factors in determining the number of test rounds.

3.1.2 Test Sequence. To provide an early indication of weapon suitability, conduct high-risk tests first. Otherwise, when one weapon must be used in several subtests, plan the test sequence so that the most abusive test will be conducted last. A suggested sequence for an engineering test of hand and shoulder weapons, using 16 weapons, is shown in Table 1; a suggested sequence for a nine-weapon test of machineguns and automatic weapons is shown in Table 2.

3.1.3 Gun Mount Compatibility. Gun mount compatibility for machineguns and automatic weapons must be established before development test (DT) II is conducted. This can be done by separate testing, by AMCCOM data, or by contractor-furnished evidence. A suitable adapter and mount base can then be designed and constructed before DT II begins. Generally, a light or dual purpose machinegun should be

capable of performing, whether hand-held or mounted on aircraft or armored vehicles. Any machinegun too heavy or having too much recoil to be fired hand-held should be capable of performing from a ground tripod mount or aircraft and armored vehicle mounts. Ground mounts (bipods, tripods, etc.) or adapters provided with the test weapon(s) but not previously tested will be included in the full range of applicable subtests (climatic, adverse, etc.), along with the test stand firings.

The term "mount base" as used herein is defined as all of the supporting structure of a test stand interposed between the gun and "ground", except the actual cradle or adapter used to secure the weapon to the mount base. The term "suitable" refers to the rigidity of the mount in N/cm (lb/in.) deflection.

3.1.4 Barrel Changes (machineguns). During all subtests involving sustained fire (except barrel performance test), the barrels are changed before reaching the cookoff level established by separate firings. The 200-round cycle mentioned in some subtests as the interval for complete cooling or change of barrels is an arbitrary figure and may have to be adjusted in accordance with the results of the cookoff tests. NOTE: For those guns that have spare barrels, and the operational concept prescribes barrel interchanges, the prescriptions should be followed.

3.1.5 Endurance Data Versus Parts Replacement. If replacement intervals are prescribed in technical publications, comply with them. The arbitrary replacement of critical weapon parts with new parts before each subtest would permit more precise evaluation of the influence of the test environment on weapon functioning. This practice, however, would negate the accumulation of data on long-term parts durability and weapon life. Therefore, following completion of each subtest, the weapons are cleaned and inspected, and only unserviceable components are replaced before the weapons are used in another subtest. Reliability and endurance test rounds depend on the design requirements and sampling risks.

3.1.6 Forced Air Cooling of Weapon Barrels. The use of forced air to accelerate cooling of weapon barrels between firing trials is permitted. The air should be directed from the chamber toward the muzzle to prevent it from washing the lubricant from the bolt or bolt carrier. This procedure should apply to all weapons when the barrel cannot be removed from the receiver. The M16 rifle can be cooled by forced air by inserting a curved tube (copper suggested) into the receiver from below, forcing air into the chamber toward the muzzle. Other weapons can be cooled in a similar manner by using an adapter tube inserted into the chamber.

TABLE 1

SUGGESTED TEST SEQUENCE FOR HAND AND SHOULDER WEAPONS USING 16 WEAPONS

Weapons	Subtests	No. of Rounds Per Gun
All	Physical characteristics	0
1,2,3	Safety	150
1,2,3,4,5	Accuracy	500
4	Cookoff	2,500
6,7,8,9,10	Endurance	6,000
11,12,13	Hot	1,000
11,12,13	Cold	3,000
11,12,13	Humidity	1,000
14,15,16	Sustained fire test	4,400
1,2,3	Water spray	600
1,2,3	Dynamic dust	140
1,2,3	Static dust	20
1,2,3	Mud test	20
1,2,3	Unlubricated	1,000
1,2,3	Fouling	1,000
1,2,3	Icing	50
1,2,3	Salt water immersion	300
5,6	Flash	100
5	Smoke	300
5	Noise	100
1,2,3	Rough handling	100
All	Maintenance evaluation	All of the above

NOTE: Add fungus subtest, if pertinent.

TABLE 2

SUGGESTED TEST SEQUENCE FOR MACHINEGUNS AND AUTOMATIC WEAPONS USING NINE WEAPONS

Guns	Subtests	No. of Rounds Per Gun
All	Physical characteristics	0
1,2,3	Assembly/disassembly	0
All	Initial dispersion	30
4,5,6	Accuracy (from test stand)	Included with reliability and endurance
1,2,3	Accuracy (bipod)	7,320
1,2,3	Accuracy (ground mount)	2,130
1,2,3	Attitudes	4,800
4,5,6	Reliability and endurance	25,000[a]
1,2,3	Cookoff	5,000
7,8,9	Hot	6,250
7,8,9	Cold	12,500
7,8,9	Icing	50
7,8,9	Temperature/humidity	1,000
7,8,9	Unlubricated	1,000
7,8,9	Water	600
7,8,9	Sand/dust tests	50 to 300
7,8,9	Salt water immersion	500
7,8,9	Mud I and II	100 to 200
2	Flash	600
3	Smoke	300
3	Noise	300
1,2,3	Belt pull	100
2	Acceleration	200
1,2,3	Barrel performance	30,000
All	Maintenance evaluation	Included in the above; if additional rounds are needed, 15,000 rounds may be fired from gun 4, 5, or 6.

[a]More rounds may be necessary, depending on design requirements and sampling risks.

NOTE: Add fungus if pertinent.

3.2 Test Weapon.

a. Disassemble the weapon, and visually examine all major components (e.g., safety and trigger mechanisms, locking arrangement) for conformance with specifications and design drawings. Record any deviations from specifications.

b. Photograph the weapon with and without its accessories and in various stages of disassembly.

c. Conduct a magnetic particle inspection of components to be subjected to stress during firing (e.g., bolt, locking lugs, barrel, muzzle device) as described in TOP/MTP 3-2-807[3]

d. Record the following for the test weapon and its ancillary equipment, as applicable:

(1) Test item nomenclature, serial number(s), and manufacturer's name
(2) Type and adequacy of packaging and preservatives
(3) Defective parts (ascertain with weapon disassembled, repair or replace, record)
(4) Number and names (establish, if necessary) for all parts
(5) Completeness of logistic support
(6) Force-displacement curve for all springs, within the designed operating range (if specified in test plan)
(7) Weapon physical characteristics

Weight of:

(a) Gun
(b) Mount
(c) Gun accessories
(d) Complete system
(e) Overall weapon
(f) Without accessories or magazine
(g) With loaded magazine
(h) With loaded magazine and accessories
(i) Individual subassemblies

Dimensions of:

(a) Gun

Test item length, width, and height, with and without accessories

Length from butt to trigger/butt to rear sight (if applicable)

(b) Mount
(c) Traverse and elevation limits, free and controlled

Sight characteristics and effectiveness

(a) Zeroing and adjustment
(b) Maximum range setting
(c) Increment of adjustment, range, and windage

(d) Total adjustment, range, and windage
(e) Battle sight setting
(f) Front and rear sight type, dimensions, and means of adjustment
(g) Sight radius
(h) Height of sight line above bore line
(i) Distance of rear sight to line of rear face of stock

Firing pin protrusion
Firing pin energy (if specified in test plan)
Trigger pull (force and stroke required to manually operate the trigger)
Headspace
Barrel length
Length of rifled bore
Direction and twist of rifling
Number of lands and grooves
Diameter across lands and grooves
Chamber dimensions
Charging force
Receiver length

(8) Time and tools necessary for the following.

NOTE: This test is conducted to determine the type and number of tools and time required to accomplish various stages of assembly and disassembly. The following measurements are taken three times by each of three test personnel:

Complete disassembly of weapon
Assembly of weapon after complete disassembly
Dismounting of the operating parts and magazine or feeder (field strip)
Assembly of operating parts and magazine or feeder
Change of barrels

(9) Magazine or ammunition box capacity and weight with and without ammunition
(10) Method of barrel attachment
(11) Type of operation
(12) Gas adjustment
(13) Type of fire (semiautomatic, automatic, etc.) and means of control
(14) Type of mechanism (open or closed bolt)
(15) Type of feed extraction, ejection, cocking
(16) Flash hider
(17) Muzzle-compensating device
(18) Bayonet, grenade launcher, or other ancillary equipment

e. Prepare a characteristics data sheet, suitable for the formal report and other purposes, consisting of a general view photograph of the weapon, along with a listing of all principal physical and performance characteristics, as described in TOP 3-2-500.

f. Verification of Sight Calibration.

(1) Assemble the weapon to the mount which is emplaced on sod 100 m from a 4.9- by 4.9-m (16- by 16-ft) target. Place two sandbags on each leg of the mount.

(2) Fire a 10-round settling burst between firings of single shots.

(3) Adjust the mount to move the center of impact of the shots to about the center of a 30.5-cm (12-in.) bull's-eye. Without additional mount adjustments, adjust the sights to result in a 6 o'clock sight picture. Without further movement of the sights, set and lock the movable elevation scale (if provided) at the 100-m graduation and the windage scale (if provided) at the zero position. Both scales are kept locked in these positions for the remainder of the tests. On weapons that allow slippage of sight scales, the scales should be slipped to read the appropriate range and deflection on the point of impact. Weapons without slip scales should have their sights adjusted to the point of impact.

(4) Fire three 10-round, single-shot groups at targets 100 m from each of the weapons.

(5) Repeat this procedure at ranges of 300 m, 500 m, and maximum range of the sight for rifle caliber weapons and at ranges of 500 m, 750 m, and maximum range of the sight for heavy caliber guns (cal .50 class and larger), with the rear sight elevated to the respective m marking for the ranges to be fired.

NOTE: 1) The "zeroing-in" phase is fired only before the 100-m test; 2) If a LASER target mechanism is available, it may be used in lieu of the above-described procedure.

g. Calibrate target system, if applicable.

3.3 Personnel. Familiarize test personnel with technical and operational characteristics of the test item as described in applicable technical manuals, requirements documents, or manufacturer's literature. Review all special warnings and safety SOP's before testing.

4. TEST PROCEDURES.

4.1 Safety Evaluation.

4.1.1 Safety Release Recommendations.

a. Safety release recommendations, required by AR 385-16[4], may be issued periodically throughout the ET, reflecting the degree of confidence in the safety of the weapon, specifically with regard to the gun crew, as the various subtests progress.

b. The first safety release recommendation is issued upon completion of the safety-related subtests. It will reflect engineering judgment based on careful study of all safety features, manual and interlock types such as those intended to prevent firing before the breech is locked, firing without the barrel locked in place, or firing without the breech lock or with it improperly assembled. Hazardous operation of manually operated assemblies such as charger, feed changer, feed covers or assemblies, trigger, manual directing handles or grips, etc., are reported. Observations are made for high-pressure gas or

particles emanating from the breech area in a direction that could be hazardous to the gunner or crew, case ejection direction that could be hazardous to the gunner or crew, insecure mounting, and gear failures resulting in a runaway gun condition.

c. Before and after firing, critical components such as breech bolts, locks and locking abutments, backplate and corresponding lugs in the receiver, and mounting lugs, when applicable, are inspected for cracks and peening. The examination is supplemented by magnetic particle inspections.

d. Generally, a safety recommendation can be made for a given design, limited to the number of rounds fired under the same conditions with at least three weapons. Subsequent safety recommendations will reflect more firing experience.

4.1.1.1 Method.

a. Conduct the safety evaluation tests described in TOP 3-2-504[5] to certify through a safety verification study in accordance with AR 385-16 that the item is safe for further testing before initiating the tests described below.

b. Conduct a safety check to determine the hazards, if any, of double feeding. The different types of ammunition (projectile configuration) supplied with the gun are evaluated for variations in feeding angles induced by the different configurations. Determination is made as to whether the nose of a cartridge being fed will strike the primer of a chambered round. If it does, conduct at least 10 trials with each type of cartridge striking a chambered, primed case (in lieu of a live round) by initiating a normal feeding cycle.

c. Continue safety evaluation throughout the tests by observing and analyzing weapon performance to identify any actual or potential hazards to personnel and equipment that might result from operation and maintenance of the weapon by representative users. A safety release recommendation will be made to TECOM in accordance with AR 385-16.

4.1.1.2 Data Required.

a. Safety Assessment Report from the weapon manufacturer through the test sponsor, through TECOM
b. Any actual or potential hazards detected
c. Controls necessary to protect personnel from health/safety hazards

4.1.2 Range Safety Tests.

4.1.2.1 Method. Validate, evaluate, and conduct required range safety tests for construction of surface danger-zone diagrams for inclusion in AR 385-63.[6]

4.1.2.2 Data Required. Collect data in accordance with AR 385-63, and prepare surface danger-zone diagram.

4.2 Cookoff Test. This test determines the maximum number of rounds that can be fired semiautomatically and automatically from the weapon before the chamber becomes hot enough to cause the propellant to cook off, i.e., ignite spontaneously, if a cartridge is resting in the chamber.

CAUTION: The cookoff test described herein covers only those hand and shoulder weapons, machineguns, and automatic weapons that do not use ammunition incorporating high explosives or fuzed projectiles. If explosive ammunition is included in a hand or shoulder weapon system (and the weapon can also be fired rapidly enough to possibly induce cookoff), special test procedures must be instituted that fully reflect the hazards of cookoff tests of high-explosive ammunition, as well as accommodate the design characteristics of the particular weapon being tested.

NOTE: All cookoff tests are to be conducted at a fixed ambient temperature with a wind speed less than 8 km/hr (5 mi/hr) with no sunlight on the barrel.

4.2.1 Method.

a. Disassemble, clean, lubricate with prescribed oil, and reassemble one test weapon.

b. Instrument the weapon for continuous temperature data by employing a thermograph and installing thermocouples at the following locations: on the exterior of the muzzle device or on the exterior of the barrel at the muzzle (if no muzzle device is present), on the exterior of the barrel immediately over the chamber mouth, and on the exterior of the barrel proper at the point of the smallest outside diameter.

c. When the projectiles are inert or contain nothing more than tracers, the person firing may remain in position at the gun during firing, but must be adequately protected. Be sure that this person uses a face shield, protective vest/clothing, heavy gloves, and ear protection. A plexiglas screen should also be employed to shield the person firing from as much direct exposure to the test weapon as practical.

d. Conduct a firing exercise, using a predetermined number of rounds, based on experience with the test weapon or one similar. Subject the weapon to the most severe firing schedule anticipated for it in service. Fire the weapon, changing belts or magazines as quickly as possible to achieve the predetermined number of rounds. Closed bolt weapons will retain a round in the chamber if firing is stopped in the middle of a belt/magazine. However, when weapons of an open-bolt design are fired, the last round must have a cartridge specially prepared to permit bolt closure without firing. This can be accomplished by assembling a primer without an anvil, or by recessing the primer 0.25 cm (0.10 in.).

e. Discontinue the test without determining cookoff point if 500 rounds can be fired without cookoff occurring, or if the weapon can no longer be fired in a normal manner because of heat. The barrel can be considered cool enough to start a new trial when temperature measurements taken on the barrel are within 0.1° C of the ambient temperature.

f. After the final round is chambered and the bolt closed, a waiting period is observed (see Table 3). NOTE: Under no circumstances will personnel be exposed after any potential cookoff round has been chambered until either a) the test is terminated by expiration of the waiting period without cookoff occurring, or b) the chambered round is fired (remotely by use of a lanyard) and not removed for inspection. The first round will usually cook off within 60 seconds,

and automatic gun action will continue to load and fire subsequent rounds until weapon temperature falls below the cockoff level. From the records on temperature, time, and rounds fired, fewer rounds can be selected in subsequent trials when the purpose is to bracket the cookoff level in terms of number of rounds fired.

g. Substantiate the point of cookoff by firing a total of five trials during which cookoffs do not occur. The confirming firing (non-cookoff level) will consist of 10 rounds less than that producing a cookoff in a continuous burst or one burst less than that producing a cookoff during burst firings.

4.2.2 Data Required. Record the following information as obtained above:

a. Continuous time-temperature recording with maximum temperature read from recording

b. Ambient temperature

c. Number of belts/magazines and rounds

d. Rate of fire when firing, and overall rate of firing, including time to change belts/magazines

e. Time to cookoff, if it occurs

f. Malfunctions in accordance with paragraph 5. Record malfunctions for each type of ammunition designed to be fired in the weapon when different ammunition components may produce various cookoff levels.

TABLE 3

DANGER ZONES AND WAITING TIMES FOR COOKOFF[7-8]

Caliber of Weapon	Danger Zone, m (yd) Inert	HE	Time to Wait for a Cookoff
5.56-mm	91 (100)	183 (200)	15 min
7.62-mm, cal.30	91 (100)	183 (200)	15 min
12.7-mm, cal. 50	91 (100)	183 (200)	15 min
20-mm	183 (200)	366 (400)	45 min
30-mm	183 (200)	366 (400)	30 min

4.3 Endurance Test. Endurance testing is conducted to determine the functioning life of the weapon. Fire hand guns and shoulder weapons at least 6,000 rounds and machineguns and automatic weapons 25,000 rounds unless otherwise specified in the test plan. Record all instances of malfunctions and failures, and replace parts when they become unserviceable. When a specific part is being studied, continue the test only long enough to determine its useful life. NOTE: Some weapons have longer lives than those specified above, particularly those that employ multi-barrels.

4.3.1 Hand and Shoulder Weapons.

4.3.1.1 Method.

a. Disassemble, thoroughly clean, lubricate, and reassemble at least five test weapons. Record headspace and barrel bore measurements for each.

b. Fire 20 rounds from each test weapon, and record velocity and accuracy. (The range distances for determining velocity and accuracy are usually established in the requirements documents; when they are not specified, refer to test reports on similar items.)

c. Fire each test weapon in accordance with the firing procedure (number of rounds, firing cycle, mode of fire, sequence of modes) specified in the requirements document. If a firing procedure is not specified, use the following:

(1) Repeat the firing cycle of Table 4 below, allowing the weapon to cool between cycles (barrel to be grasped comfortably with the bare hand), until at least 6,000 rounds have been fired for each test weapon. Conduct selected firing cycles, using the weapon attitudes of Table 5.

TABLE 4

FIRING CYCLE

Firing Mode	Magazine 20 rounds	Magazine 30 rounds
Automatic* - 3- to 5-round bursts	X	X
Automatic* - single burst	X	X
Semiautomatic** - 10 to 30 rounds per minute	X	X
Automatic* - 3- to 5-round bursts	X	-
Semiautomatic** - 10 to 30 rounds per minute	X	X
Total rounds per cycle	100	120

*Weapons without automatic firing capability are fired semiautomatically.
**Weapons without semiautomatic firing capability are fired in 3- to 5-round bursts.

(2) Measure and record cyclic rate of fire for each burst fired automatically.

(3) After every 1,000 rounds, disassemble, inspect, clean, and lubricate the entire mechanism unless otherwise specified, and fire 20 rounds for velocity and accuracy at the ranges previously established.

TABLE 5

WEAPON FIRING ATTITUDES

Firing Cycle (200-round groups)	Weapon Position (hand-held)	
A, B	Loosely	
A, B	Right side up	0° elevation
A, B	Left side up	
A, B	Normally	80° elevation
A, B	Loosely	
A, B	Normally	-80° elevation
A, B	Loosely	

A = as specified in Table 4.
B = automatically to even the round count to 200.

d. After the specified number of rounds have been fired, fire 20 rounds again for velocity and accuracy, and record bore and headspace measurements.

4.3.1.2 Data Required. Record the following:

a. Muzzle velocity
b. Target accuracy and dispersion
c. Cyclic rate of automatic fire
d. Ambient temperature
e. Malfunctions, breakages, and replacement parts, in accordance with paragraph 5
f. Bore and headspace measurements

4.3.2 Machineguns and Automatic Weapons. Fire these weapons 25,000 rounds each in accordance with the basic outline in Table 6, using firing schedules applicable to the weapon. The procedure is as follows.

4.3.2.1 Method.

a. Shoulder-fired, bipod-mounted weapons and other ground-mounted (tripod, etc.) weapons are fired from their respective mounts, as well as being fired from a test stand.

b. Initially, each endurance and reliability weapon is fired 200 rounds from a test stand, bipod, and tripod (as applicable) for cyclic rate measurements and observation for any gross operational problems. If a major operational problem is encountered during this firing or during subsequent firings, a kinematics investigation is conducted (TOP 3-2-826[9]).

c. After 200 rounds have been fired from the test stand and each mount involved, subject each weapon to the firing outlined in Table 6, rotating from test stand to bipod to ground mount (tripod, etc.), as applicable, after each 5,000 rounds, until 25,000 rounds have been fired from each weapon. In all instances, the test stand firing will consist of the larger number of rounds.

For example, if one mount is involved, the test stand firing will comprise 15,000 of the 25,000 rounds; with two mounts, each weapon will be fired a total of 10,000 rounds from a test stand, and 10,000 and 5,000 rounds, respectively, from the two mounts, with the larger number of "mount" rounds fired from the mount that (as determined from earlier firing) will more critically affect functioning.

d. For functioning information in the ground mount phases, the test plan will be designed to include:

(1) Firing at extreme left and right deflections, maximum elevation, and maximum depression

(2) Firing with and without the mount sandbagged, and from sand, sod, and hard ground

e. During the test, change the barrels before reaching the cookoff level (established during cookoff testing) in order to safely evaluate malfunctions. Fire the weapons without additional lubrication or cleaning/lubrication until there is degradation in performance. Initially, relubrication alone is applied to correct degradation in performance (rate reduction or malfunction); if this fails to restore satisfactory performance, then disassembly, cleaning, inspection, and lubrication are performed before firing is resumed. These lubrication/maintenance intervals are then applied throughout the remaining firing in this subtest.

TABLE 6

FIRING SCHEDULE, ENDURANCE

Stage	Number of Rounds	Feed[a]	Firing Schedule[b] (Table 6)
1	1,000	LH	1,2,3,4,5
2	1,000	RH	1,2,3,4,5
3,5,7,9,11,13,15,17,19, 21,23,25	repeat stage 1		
4,6,8,10,12,14,16,18, 20,22,24	repeat stage 2		

[a]Alternate left- and right-hand feeding only if applicable
[b]Use firing schedules in numerical order for each stage, firing 200 rounds each schedule. (Schedules may be adjusted to conform with specifications.) If the weapon has multiple cyclic rate of fire capability, vary the cyclic rate each 200-round cycle or each stage, depending on the number of cyclic rates available.

NOTE: Record malfunctions, parts life, and cyclic rates of fire (when applicable) throughout the firings.

TABLE 7

FIRING SCHEDULES

Schedule	Description
1	One round every 3 seconds
2	5-round burst every 3 seconds
3	20-round bursts at the rate of 85 rounds per minute
4	50-round burst every 30 seconds
5	Continuous burst

4.3.2.2 Data Required. Record data as listed in 4.3.1.2.

4.4 Accuracy-Dispersion Test. The difference between accuracy and dispersion is explained in TOP 4-2-829.[10] In tests of weapons, a dispersion test in particular requires that the effect of variations in ammunition be eliminated insofar as possible. Thus, in accuracy-dispersion tests of weapons, the lot of ammunition must be one that has been proven to have a small dispersion.

4.4.1 Hand Guns and Shoulder Weapons. The accuracy-dispersion test described is conducted to determine the accuracy-dispersion of the weapon at different ranges, in various modes of fire, with and without the employment of various weapon accessories.

4.4.1.1 Method.

a. Disassemble, clean, lubricate with prescribed oil, and reassemble at least five test weapons.

b. Ensure that the velocity of the transverse wind is no greater than 16 km/hr (10 mph) or varies by more than 8 km/hr. These are the maximum wind velocity conditions permitted and are not necessarily acceptable for all small arms projectiles at all ranges. Records of previous tests of the same or closely related weapon should be consulted before establishing the maximum permitted wind velocities for the test.

c. Fire enough rounds to ensure that each test weapon is correctly sighted on target.

d. After the sighting rounds, fire at least three (preferably five) targets as follows:

NOTE: Multiple paper screen targets may be employed in a row and fired upon simultaneously at the various ranges. However, if results indicate a nonlinearity in dispersion that could be attributed to projectile deflection as a result of passing through one or several of these targets, then targets must be fired upon individually.

(1) Three master riflemen (National Rifle Association-qualified) each fire 10 rounds semiautomatically from the test weapon at each target from a bench rest (without muzzle flash suppressor) at ranges prescribed in the test plan or specifications.

(2) Repeat (1) above with normal muzzle attachments assembled.

(3) Three master riflemen each fire 30 rounds at each target automatically in bursts of three rounds at a range of 50 m from a prone position.

4.4.1.2 Data Required. Measure and record the following:

a. X and y coordinates of each impact
b. Vertical and horizontal standard deviation of impacts on each target
c. Other data as specified in the test plan (mean radius, extreme spread, etc.)
d. Velocity and direction of wind (outdoor range)
e. Failures to trace (if applicable)
f. Total number of cartridges fired in barrel
g. Malfunctions, if any

Other special accuracy tests may be required to evaluate particular capabilities of the weapon design or to examine specific technical requirements. These include tests to determine the effect of the attached bayonet.

4.4.2 Machineguns and Automatic Weapons.

4.4.2.1 Initial Dispersion. This test is conducted to determine the inherent dispersion of all weapons submitted for test and to select three weapons for the accuracy-dispersion test.

a. Method. Fire three 20-round bursts, fully automatic, from each weapon at a target placed at a 2540-cm (1,000-in.) range. Inert (ball) type ammunition is used. The firings are conducted from a test stand secured to a rigid base.

b. Data Required. Measure vertical and horizontal dispersions on all targets. From these data, the best, worst, and average weapon are selected for the accuracy-dispersion test.

4.4.2.2 Accuracy-Dispersion. This test is to determine the inherent accuracy and dispersion characteristics of the test weapons throughout the tactical ranges when fired from a test stand secured to a rigid base.

The three weapons selected from the initial dispersion tests are used in this test.

This test should be conducted when the weapons are in a "new" condition. Requirements for specific weapons, however, may dictate that certain parts of the test be repeated at the midpoint and end of gun life.

Position targets perpendicular to the line of fire. Record at least five targets for each range.

NOTE: Within certain constraints, linear equations can be developed to predict long-range dispersion from short-range firings of automatic weapons and small arms, provided that aiming and firing are very carefully controlled and documented. In these cases, conduct dispersion tests of production small arms

systems and small-caliber automatic weapon systems at three ranges, the farthest being only one-half the required maximum range. The dispersion at the far range will be determined by linear equations derived from the dispersion at the three close-in targets.[11]

a. Ground-Mounted Machineguns (Three Weapons)

Scope: Evaluation of the features and accessories that adapt the weapon to the flexible or ground role.

Limitations: The tests outlined below are performed in addition to the other tests specified in this TOP, unless the flexible gun has been adapted from previously tested and accepted fixed models that were subjected to those tests.

Objective: To determine the performance and durability of the weapon, mount, and combination in the anticipated employment by troops, when dismounted or when mounted as a flexible gun.

(1) Fire five 20-round groups from a rigid test stand to determine weapon dispersion at 1000-in. range (obtained during test described in paragraph 4.4). The short 1000-in. range was selected to minimize weather effects.

(2) Fire five 20-round groups (1000-in. range) at 0° elevation and zero deflection for accuracy.*

(3) Fire five 20-round groups (1000-in. range) at 0° elevation and maximum right deflection for accuracy. Repeat at maximum left deflection.*

*NOTE: Conduct firing in steps (2) and (3) with and without the mount sandbagged, and from sand, sod, and hard ground.

(4) Fire five 20-round groups (1000-in. range) at 0° elevation, zero deflection, and with mount legs fully extended (with and without legs sandbagged) from hard ground.

b. Shoulder-Fired, Bipod-Mounted, Light Machineguns

With sights set for the appropriate range, conduct the following firing with three weapons at 91.4 m (100 yd) (see paragraph 4.4.2.2.b for accuracy data to be recorded):

(1) Five 10-round targets semiautomatically from a bench rest without employing the bipod.

(2) Five 10-round targets semiautomatically from the prone position using the bipod.

(3) If a mount is provided, five 10-round targets semiautomatically with the gun installed on the mount.

Three gunners each will fire the following:

(1) Five 20-round targets automatically from a bench rest without employing the bipod.

(2) Five 20-round targets automatically from the prone position using the bipod.

(3) If a mount is provided, five 20-round targets automatically with the gun installed on the mount.

A test is conducted to investigate the accuracy that can be obtained when the gun is fired under various conditions similar to those encountered in combat. Three gunners each fire the following course:

(1) Starting with a fouled bore, fire three 10-round targets semiautomatically from the prone position using the bipod.

(2) Disassemble the gun (field strip), clean, oil, and reassemble.

(3) Starting with a cold and oiled bore, fire three 10-round targets semiautomatically from the prone position using a bipod.

(4) Fire three 10-round targets semiautomatically from a bench rest without employing a bipod.

(5) Fire 200 rounds automatically (without recording hits).

(6) Immediately after the 200 rounds are fired, fire three 10-round targets semiautomatically from the prone position using a bipod.

(7) Fire three 10-round targets immediately from a bench rest without employing a bipod.

Three individuals fire as many aimed shots as possible in a 1-minute period. Each fires three times using semiautomatic fire and three times using automatic fire. Hits are recorded on the E-target (kneeling silhouette type).

b. Data Required.

(1) Data obtained are those required to determine the ability of the weapon to meet the accuracy specified. Mode of fire, rounds per burst or shots per target, types of ammunition, and range (minimum, maximum, and intermediate) are obtained from specifications (requirements documents) pertaining to the test weapon.

(2) Except when otherwise specified, determine the x and y coordinates of all targets. From the coordinate data, horizontal and vertical standard deviations, horizontal and vertical spread, mean radius, and deviation of the center of impact (CI) from the point of aim (when applicable) are provided. The point of aim is determined by means of a boresight reading, test mount sight, or with gun sights (if provided with the weapon); the weapon is relayed on the aiming point after each shot or group, as applicable.

(3) Accuracy results of shot groups containing tracer rounds (combat load) will require identification of the tracer impacts. Three analyses will be made: all shots, tracer alone, and nontracer alone, in order to determine the variations in characteristics.

4.5 Climatic Conditions Tests. Conduct functioning tests in climatic chambers to determine the effects of extreme high and low temperatures and icing on weapon performance. Selection of test temperatures for the climatic tests is based directly on the stated requirement for the test weapon. Test temperatures selected from AR 70-38[12] are presented in Table 8.

TABLE 8

TEST TEMPERATURES, EXTREME CONDITIONS

Condition	Temperature °F	Temperature °C
Hot	160	71
Basic cold	-35	-37
Cold	-50	-46
Severe cold	-60	-51

During environmental functioning tests, it is usually desirable, when safety permits, to condition the weapons fully loaded, including leaving a round in the weapon chamber for closed bolt firing designs. Weapons firing from the open-bolt position are prepared by leaving the chamber empty and the bolt in the seared position. For some tests and because of safety precautions, it may be more realistic to condition the weapons "half loaded", i.e., with the bolt in the battery position and the chamber empty, so that one function of the charging handle completely loads the weapon. If test results indicate a high number of first round failures, it may be necessary to manually operate the firing mechanism several times to restore proper operation of the weapon. When this action is performed, it will be so noted.

When testing weapons with multiple cyclic rates of fire, rotate the firing cycles (barrel change) among the various rates of fire.

Specified lubricants to be used in each environmental test are determined by reference to appropriate manuals or other authority. In addition to observations of general weapon performance, also report requirements for additional lubrication and cleaning. Do not clean or re-lubricate test weapons unless required for completion of the test.

4.5.1 High Temperature Test. This subtest determines the effect of extreme high temperatures on the functioning performance of weapons.

a. Method.

(1) Condition at least three test weapons, spare barrels (if applicable), and the ammunition in a climatic chamber for at least 6 hours at a temperature of 71° C (which takes into account heating effects due to solar radiation) (see DPS-1692 [AR 705-15[13]]). The minimum rounds to be fired through each weapon are shown in Table 9.

TABLE 9

AMMUNITION REQUIREMENTS (MINIMUM)

Type of Weapon	Number of Rounds per Weapon[a]	
	Low Temp.	High Temp.
Hand and shoulder	3,000	1,000
Machinegun	12,000[b]	6,000[c]

[a]Unless otherwise specified
[b]Or the number of rounds equal to 50% of the minimum required receiver life
[c]Or the number of rounds equal to 25% of the minimum required receiver life

(2) Test each hand and shoulder weapon within the chamber as follows:

(a) Fire 1,000 rounds (in 100-round cycles) at 2-hour (minimum) intervals in the manner indicated in Table 4, unless otherwise specified in the test plan, requirements documents, etc.

(b) Measure cyclic rate of fire for each automatically fired burst.

(c) Do not perform maintenance during the 1,000-round cycle unless otherwise specified.

(d) Use a paper or plywood target outside the climatic chamber 25 m from the weapon muzzle to evaluate gross conditions of bullet instability.

(e) After 1,000 rounds have been fired through each weapon, remove the weapons from the conditioning chamber, and disassemble, thoroughly inspect, clean, and oil each one.

(3) Test each machinegun within the chamber as follows:

(a) Fire 5,000 (minimum) rounds (in 200-round cycles) at the designed sustained rate-of-fire specified in applicable requirement documents. If no designed sustained rate-of-fire is specified, fire the 200-round cycles at a sustained rate-of-fire of 85 shots per minute in 5-round bursts, approximately. The high temperature test is conducted without a scheduled time interval between firings. As a precaution against cookoffs, however, barrels are replaced (with barrels previously conditioned at 71° C after each 200 rounds).

(b) Measure cyclic rate-of-fire for each automatically fired burst.

(c) Perform maintenance at intervals specified in applicable requirements documents. If no scheduled maintenance intervals are specified, do not perform maintenance unless weapon operation is degraded due to fouling as evidenced by loss of cyclic rate, increased frequency of malfunctions, etc. All maintenance is to be performed at the test temperature.

(d) Use a paper or plywood target outside the climatic chamber 25 m from the weapon muzzle to evaluate gross conditions of bullet instability.

(e) If the weapon is fired remotely using a gun solenoid, the voltage selected for the test should be the maximum operating voltage specified.

(f) After at least 6,000 rounds have been fired through each weapon, remove the weapons from the conditioning chamber, and disassemble, thoroughly inspect, clean, and oil each one.

b. Data Required. Record the following:

(1) Temperature and exposure times
(2) Cyclic rate of automatic fire
(3) Malfunctions in accordance with paragraph 5
(4) Any damage noted during inspection
(5) Evidence of bullet instability
(6) All maintenance actions performed

4.5.2 Low Temperature Test. This subtest determines the effect of extreme low temperatures on the functioning performance of weapons.

a. Method.

(1) Condition at least three weapons, spare barrels (if applicable), accessories, and the ammunition in a climatic chamber for at least 6 hours at the applicable low temperature specified in AR 70-38 as interpreted in Table 6.

(2) Test each hand and shoulder weapon within the chamber as follows:

(a) Fire 1,000 rounds through each weapon as described in paragraph 4.5.1.a(2) (first four steps).

(b) After 1,000 rounds have been fired through each weapon, remove the weapons from the conditioning chamber and disassemble, thoroughly inspect, clean, and oil each one. Record any changes noted.

(c) Repeat the test two more times.

(3) Test each machinegun within the chamber as follows:

(a) Fire 12,000 rounds (minimum) as described in paragraph 4.5.1.a(3) (steps (a) through (d) and (f)). Recondition the guns and barrels at testing temperature for at least 2 hours between each 200-round cycle. The weapon (in the climatic chamber) is cleaned with dry rags, inspected, and relubricated after each 3,000 rounds of firing.

(b) Observe conditions peculiar to operation at low temperature such as increased charging forces, increased power requirements, and maintenance difficulties including minor adjustments and problems in field stripping when using cold weather gear.

(c) If the weapon is fired remotely using a gun solenoid, the voltage selected for this test should be the minimum operating voltage specified. If unsatisfactory operation results, determine increased voltage required for satisfactory operation.

b. Data Required. Record data as specified in paragraph 4.5.1.b.

4.5.3 Humidity Test. This subtest determines the effect of high humidity on the functioning performance of weapons.

4.5.3.1 Hand and Shoulder Weapons.

4.5.3.1.1 Method. Test these as follows:

a. Expose at least three test weapons and a minimum of 3,000 rounds of ammunition (divided into 125-round groups) to the temperatures and humidities indicated in Table 10 for 10 days. Record exposure conditions and times.

TABLE 10

STORAGE SCHEDULE FOR HUMIDITY TEST (24 HOURS)

No. of Hours		Temperature °C	Temperature °F		Relative Humidity (%)
2	increase to...	41	105	and...	90
16	maintain at...	41	105	and...	90
2	decrease.....	41 to 21	105 to 70...	increase to..	95
4	maintain at...	21	70	and...	95

b. On the third, fifth, eighth, and tenth days of exposure, fire 250 rounds of ammunition in 125-round groups. The first 100 rounds of each group are fired in the manner (i.e., mode of fire, sequence of modes) specified in the requirements documents, etc. When not specified, the procedure in the latest PD for the M16A1 rifle is used. Weapons without semiautomatic fire capability are fired in 3- to 5-round bursts in lieu of the semiautomatic fire. Weapons without automatic fire capability are fired in the semiautomatic mode only. Firing of a control weapon will be similar to that of the test weapon. The final 25 rounds are fired in short bursts. NOTE: The 25-m target may be eliminated in the humidity firings.

c. After 1,000 rounds have been fired through each weapon, remove the weapons from the conditioning chamber and disassemble, thoroughly inspect, clean, and oil each one. Record any damage noted.

4.5.3.1.2 Data Required. Record data as specified in 4.5.1.b

4.5.3.2 Machine Guns.

4.5.3.2.1 Method. Test as follows:

a. Subject the test weapons, spare barrels (if required), and ammunition to the temperatures and humidities indicated in Table 10 for 10 days without cleaning or adding lubricant. The schedule conforms to the high humidity-temperature cycle of TOP 4-2-820[14], and is considered to meet the requirements of the hot-humid climate of AR 70-38.

b. Fire 250 rounds on each third, fifth, eighth, and tenth day, using firing schedule 4 (Table 7) which is 50-round bursts every 30 seconds.

c. After 1,000 rounds have been fired through each weapon, remove the weapons from the conditioning chamber and disassemble, thoroughly inspect, clean, and oil each one. Record any damage noted.

4.5.3.2.2 Data Required. Record data as specified in 4.5.1.b.

4.5.4 Water Spray (rain) Test. This subtest is an accelerated test to determine the effects of a heavy rainfall on weapon performance.

a. Method.

(1) Disassemble, clean, lubricate, and reassemble the required weapons.

(2) Adjust the water supply to provide a spray of water falling at a rate of about 10 mm (0.4 in.) per minute, or 610 ±80mm (24 ±3 in.) per hour from a height great enough to direct the spray over the entire weapon.

(3) Conduct the water spray test for hand gun and shoulder weapons according to the basic sequence of operations listed in Table 11. For machineguns and automatic weapons, conduct the test as shown in Table 12.

NOTE: There is no break in time between the end of Part I and the beginning of Part II of the table.

b. Data Required. Record the following:

(1) Rate of rainfall
(2) Water and ambient air temperatures
(3) Malfunctions in accordance with paragraph 5
(4) Cyclic rate of automatic fire

TABLE 11

WATER SPRAY TEST FOR HAND GUNS AND SHOULDER WEAPONS

Test Condition	Exposure Time (minutes)	Cumulative Exp. Time (minutes)	Rain (cm)	Rain (in)	Cumulative Rain (cm)	Cumulative Rain (in)
		Part I				
Weapon Horizontal						
a. Bolt open	5	5	5.1	2.0	5.1	2.0
b. Loaded, bolt closed	5	10	5.1	2.0	10.2	4.0
c. 100 rounds fired as specified in 4.3.1.1	4	14	4.1	1.6	14.2	5.6
d. Bolt open	5	19	5.1	2.0	19.3	7.6
e. Loaded, bolt closed	5	24	5.1	2.0	24.4	9.6
f. 100 rounds automatic	4	28	4.1	1.6	28.4	11.2
		Part II				
Weapon Muzzle Up*						
a. Bolt open	5	33	5.1	2.0	33.5	13.2
b. Loaded, bolt closed	5	38	5.1	2.0	38.6	15.2
c. 100 rounds fired as specified in 4.3.1.1	4	42	4.1	1.6	42.7	16.8
d. Bolt open	5	47	5.1	2.0	47.8	18.8
e. Loaded, bolt closed	5	52	5.1	2.0	52.8	20.8
f. 100 rounds automatic	4	56	4.1	1.6	56.9	22.4
Weapon Muzzle Down*						
a. Bolt open	5	61	5.1	2.0	62	24.4
b. Loaded, bolt closed	5	66	5.1	2.0	67.1	26.4
c. 100 rounds fired as specified in 4.3.1.1	4	70	4.1	1.6	71.1	28.0
d. Bolt open	5**	75	5.1**	2.0	76.2	30.0
e. Loaded, bolt closed	5**	80	5.1**	2.0	81.3	32.0
f. 100 rounds automatic	4**	84	4.1**	1.6		

*Before attempting to fire, hold the weapon with muzzle down; unlock the bolt slightly, and attempt to remove water accumulated in the bore.

**Or as required to finish the program with at least 81 cm (32.0 in.) cumulative rain total.

TABLE 12

WATER SPRAY TEST FOR HAND GUNS AND SHOULDER WEAPONS

Part I

Test Condition	Exposure Time (minutes)	Cumulative Exp. Time (minutes)	Rain (cm)	Cumulative Rain (cm)
Weapon Horizontal				
a. Bolt closed, half loaded	5	5	5.1	5.1
b. Bolt open, fully loaded	5	10	5.1	10.2
c. 100 rounds[a]	4	14	4.1	14.2
d. Bolt closed, half loaded	5	19	5.1	19.3
e. Bolt open, fully loaded	5	24	5.1	24.4
f. 100 rounds[b]	4	28	4.1	28.4
Part II				
Weapon Muzzle Up[c]				
a. Bolt closed, half loaded	5	33	5.1	33.5
b. Bolt open, fully loaded	5	38	5.1	38.6
c. 100 rounds[a]	4	42	4.1	42.7
d. Bolt closed, half loaded	5	47	5.1	47.8
e. Bolt open, fully loaded	5	52	5.1	52.8
f. 100 rounds[b]	4	56	4.1	56.9
Weapon Muzzle Down[c]				
a. Bolt closed, half loaded	5	61	5.1	62
b. Bolt open, fully loaded	5	66	5.1	67.1
c. 100 rounds[a]	4	70	4.1	71.1
d. Bolt closed, half loaded	5[d]	75	5.1[d]	76.2
e. Bolt open, fully loaded	5[d]	80	5.1[d]	81.3
f. 100 rounds[b]	4[d]	84	4.1[d]	

[a]Firing schedule 3 (Table 7)
[b]Firing schedule 2 or if weapon has a selector, firing schedule 1
[c]Before attempting to fire, unlock the bolt to allow water accumulated in bore to drain (closed bolt weapons)
[d]Or as required to finish program with at least 81 cm cumulative rain

4.5.5 Sand and Dust Tests.

4.5.5.1 Dynamic Test. This subtest is conducted to determine the effects of blowing sand and dust on weapon performance. Conduct firing in one of the sand and dust facilities described in Appendix A.

a. Method.

(1) Prepare a sand and dust mixture of angular structure, with particle size distribution determined by weight, using the US standard sieve series. The composition may be obtained by mixing 42% "No. 1 dry" sand, 8% "No. 3 O-Rok" sand, and 50% 140-mesh silica flour, which will provide the blend shown in Table 13. NOTE: Supply sources are available on direct inquiry to Commanding Officer, Aberdeen Proving Ground, ATTN: STEAP-MT-I, Aberdeen Proving Ground, Maryland 21005.

TABLE 13

COMPOSITION OF SAND AND DUST MIXTURE
(by percent particles, by weight, retained in sieves)

Sieve Size (US gage sieve no.)	Percent of weight retained	Particle Size (microns)
20	3	842 to 1000
30	5	595 to 841
45	17	355 to 595
60	14	251 to 354
100	10	150 to 250
(pass 100)	<1	. . . . .
140-mesh silica flour		
140	1	105 to 149
200	4	74 to 105
325	7.5	44 to 74
(pass 325)	37.5	less than 44

Calibrate the sand and dust feeder of the facility to dispense the mixture at a rate of 100 $\pm$25 g/min/m^2 over the area concerned.

(2) Clean and lubricate three test weapons. Place one weapon and complement of ammunition in the facility. The weapon should be in the orientation in which it would normally be fired; multiple tests may be necessary if there is more than one possible orientation. The ammunition complement will be seven magazines for magazine-fed weapons; for belt-fed infantry weapons, no less than 25 rounds below that required to produce a cookoff in the gun; or one full complement of ammunition for weapons using special ammunition containers or feed mechanisms (such as armored vehicles, anti-aircraft systems, aircraft weapons, etc.).

Fully load the test weapon and place any safety switch in the "safe" position. Close any dust covers incorporated in the weapon. Engineering judgment is necessary to determine the protection given the ammunition. Remaining magazines

are normally covered with plastic bags. Ammunition in standard shipping and storage containers is usually left sealed. Ammunition is left exposed when it can be expected to be exposed in combat.

(3) Turn on the dust dispenser and allow to operate for one minute before firing. The firing schedule for magazine-fed weapons is one magazine every 20 seconds, with the first five fired full automatic and the last two fired in short bursts. For belt-fed weapons, the schedule is 20 rounds every 20 seconds, with the first half of the ammunition fired in 20-round bursts and the last half fired in short bursts. Firing schedules may also be based on combat scenario, weapon specifications, or other available information.

(4) Use a cyclic rate recorder continuously throughout each test so that a chronological record of total test time, time to first stoppage, time to clear, etc., as well as cyclic rate of fire are obtained. The total time that the bolt remains open (to clear stoppages, to change magazines, etc.) is a critical measurement in this test.

(5) If the firings are performed without any malfunction that cannot be readily cleared by immediate action, i.e., one requiring the use of tools or weapon disassembly, continue the test until such a malfunction occurs or until all of the ammunition is fired.

(6) Repeat the test with the other two weapons.

b. Data Required. Record the following:

(1) Sand and dust dispensing rate
(2) Cyclic rate of automatic fire
(3) Malfunctions in accordance with paragraph 5
(4) Number of rounds fired

4.5.5.2 Static Test. This test also determines the effects of blowing sand and dust on weapon performance, but the firing is conducted after the weapon is removed from the sand and dust environment. Thus, the exposure box need not accommodate firings. Use the same sand and dust mixture listed in Table 13.

4.5.5.2.1 Method. Clean and lubricate three test weapons and close the muzzles with tape.

a. Hand Guns and Shoulder Weapons.

(1) For weapons fired from a closed bolt, chamber a round. Weapons fired from an open bolt will have the bolt open on the empty chamber. Close the dust cover and set the safety on "safe." Assemble a fully loaded magazine in the weapon.

(2) Expose the weapon as follows:

Place the weapon and a second loaded magazine in the center of the box, forward from the pour hole, and fasten the box lid.

Operate the blower handle at about 60 rpm as the sand and dust mixture is poured through the hole at a rate of 2.3 kg (5 lb) per minute.

After 1 minute, stop the blower, remove the lid, and turn the weapon and magazine upside down in the box. Replace the lid and repeat the sand and dust blast for another minute.

(3) Remove the weapon and spare magazine from the box and wipe clean with bare hands. Clean congested parts as much as possible by blowing sharply or by jarring the weapon. Remove the tape from the muzzle.

(4) Fire a full magazine from the weapon. If repeated malfunctions make this impossible, attempt to fire with the second magazine. If firing is still unsatisfactory, attempt to fire with a clean magazine, container, bandolier, etc., loaded with clean ammunition. If repeated malfunctions make it impossible to fire all of the ammunition, field strip and clean the weapon in accordance with the applicable operator's manual. Then attempt to fire the remaining ammunition. If repeated malfunctions make it impractical to fire the remaining ammunition, completely disassemble the weapon in accordance with applicable technical manuals. Attempt to determine the exact source of dust-induced malfunctions. Reassemble the weapon and fire to verify serviceability.

(5) Repeat the test with the remaining weapons.

b. Machineguns and Automatic Weapons.

(1) Fully load the weapons with a 50-round belt of ammunition and place the safety in the ON position. Place the gun in the sand/dust box but not directly underneath the pour hole. Expose the test items to the mixture for 1 minute with their top sides up and for 1 minute upside down while the blower is turned at a handle speed of 60 revolutions per minute, and the mixture is poured at a rate of 2.3 kg per minute through the hole.

(2) After removing the weapon from the box, attempt to clean the weapon and ammunition by wiping with bare hands, blowing on congested areas, and jarring the weapon and ammunition, WITHOUT opening the weapon cover (or breech). Remove the tape from the muzzle.

(3) Attempt to fire 50 rounds in a continuous burst. If the weapon fails to function satisfactorily, open the weapon feed or breech cover and perform additional cleaning, as specified above, in an attempt to obtain proper functioning. If satisfactory functioning is still not obtained, make another attempt to fire using a clean belt of ammunition.

(4) If the weapon is fired from an open bolt and the gun fails to function satisfactorily with "clean" ammunition, repeat the test with the bolt closed and the weapon half loaded before the exposure.

(5) Repeat the test with the remaining weapons.

NOTE: If repeated malfunctions make it impossible to fire all of the ammunition, conduct field strip operations (and completely disassemble the weapon if subsequently deemed necessary) as described for hand guns and shoulder weapons, and attempt to fire.

4.5.5.2.2 Data Required. Record the following:

(1) Number of rounds fired
(2) Malfunctions in accordance with paragraph 5
(3) Number of attempts to overcome each malfunction
(4) Sand and dust dispensing rate
(5) Maintenance actions performed

4.5.6 Mud Test. This subtest determines the effects of mud on weapon performance.

4.5.6.1 Hand Guns and Shoulder Weapons.

4.5.6.1.1 Method.

a. Clean and lubricate three test weapons and close the muzzles with tape. Load three magazines for each weapon.

b. Prepare a mud bath as described in 4.5.6.2.1.

c. After immersing the weapon, wipe it with bare hands to remove excess mud, remove the tape from the muzzle, and fire 30 rounds (one 30-round burst in automatic weapons). NOTE: The predominant malfunction encountered in this test is that the bolt cannot be retracted or closed by hand or by gun action without considerable effort. In most instances, it will be necessary to strike the bolt-retracting lever a sharp blow with the hand to open the action.

d. If firing is unsatisfactory with the magazine assembled in the weapon, expose and use a second loaded magazine as in the static dust test. If firing is still unsuccessful, use a clean magazine.

e. If firing with a clean magazine is unsatisfactory, immerse the entire weapon (with the bolt open) and the contaminated magazines in clean water, and agitate them as rapidly as possible for 60 seconds. Try to fire again after draining the water from the weapon bore.

f. If firing continues to be unsatisfactory, perform a 3-minute field stripping operation, with parts hand-wiped with a cloth, to determine whether the weapon can be returned to a serviceable condition in the field.

4.5.6.1.2 Data Required. Record the following:

a. Number of rounds fired
b. Malfunctions in accordance with paragraph 5
c. Number of attempts to overcome each malfunction
d. Maintenance actions performed

4.5.6.2 Machineguns and Automatic Weapons.

4.5.6.2.1 Mud Test No. 1.

a. Method. This test is conducted by immersing the weapon in a mixture of 4.5 kg (10 lb) of montmorillonite clay, 0.9 kg (2 lb) of silica sand, and about 45.5 l (48 qt) of water. The amount of water to be added to the sand and clay mixture may vary with the moisture content of these components. The water content will be limited to the quantity producing a mud viscosity of about 4,600

centipoises as determined with a Brookfield viscometer. The measurement conditions are as follow:

Room temperature of 23° ±1.7° C (73° ±3° F)
Spindle No. 3 used at 10 rpm
Container diameter greater than 7 cm (2-3/4 in.)
One-minute test duration

NOTE: Sources of supply are available on direct inquiry to Commanding Officer, Aberdeen Proving Ground, ATTN: STEAP-MT-I, Aberdeen Proving Ground, Maryland 21005.

The silica sand mixture used in this test is the "No. 3 Q-Rok", one of the components of the mixture used in the sand-dust tests. This sand is of angular structure with the characteristics shown in Table 14.

TABLE 14

CHARACTERISTICS OF SAND USED IN MUD TEST MIXTURE

Sieve No.	% of Grains Retained
16	1.2
18	12.5
20	26.9
30	51.3
40	7.3
50	0.6
(pass 50)	0.2

(1) Clean and lubricate three test weapons. Tape the muzzle of one weapon shut; fully load the gun, and place the safety in the ON position. Completely immerse the weapon (and 50-round belt of ammunition or loaded magazine and mount if applicable) in a horizontal position for 60 seconds.

(2) After removing the gun from the mud, remove the tape from the muzzle. Without opening the weapon cover or breech, attempt to clean the weapon and ammunition by wiping with bare hands, blowing on congested areas, and jarring the weapon and ammunition.

(3) As in the static sand-dust test, attempt to fire 50 rounds in a continuous burst. If the weapon fails to function satisfactorily, open the cover and perform additional cleaning, as specified above, to obtain proper functioning. If the weapon still fails to function, attempt to fire using a clean belt of ammunition (or magazine when applicable).

(4) If firing is unsatisfactory, immerse the entire weapon (with the bolt open) and the contaminated ammunition in clean water, and agitate as rapidly as possible for 60 seconds. Then attempt to fire again.

(5) If functioning continues to be unsatisfactory, perform a field stripping operation, with parts hand-wiped with a cloth and then relubricated, to determine whether the weapon can be returned to a serviceable condition in the field.

(6) Test the two remaining weapons as described above.

b. Data Required. Record data as listed in 4.5.6.1.2.

4.5.6.2.2 Mud Test No. 2.

a. Method. Conduct this test in a manner identical to that of Test No. 1, except that the weapons and ammunition are permitted to dry for at least 4 hours after being removed from the mud bath.

4.5.7 Icing Test (-6.7° C [20° F]). This subtest determines the operability of a weapon after exposure to freezing rain (see TOP 2-2-815[15]) resulting in a glazed coating.

4.5.7.1 Method.

a. Disassemble, clean, lubricate, and reassemble at least three test weapons, and tape the muzzles closed.

b. Expose the weapons (and ammunition) to a temperature of -17.8° C for 6 hours.

c. Raise the chamber temperature to -6.7° C, and subject the test items to a light spray of water until 3.2 to 6.4 mm (1/8 to 1/4 in.) of ice accumulates on the top surface of hand and shoulder weapons, including shoulder-fired machineguns and 6.4 to 12.8 mm (1/4 to 1/2 in.) on other machineguns. Each gun is exposed with a 50-round belt of ammunition (or loaded magazine) engaged but with the chamber empty and the bolt closed, requiring charging to complete weapon loading. Weapons firing from the open-bolt position are readied by closure of the bolt on an empty chamber, requiring only retraction of the bolt to fully load each weapon. When belt-fed weapons are provided with a belt container attached to the weapon, the container will be used.

d. Remove the tape from the muzzles following exposure to icing. Only tools or other equipment normally available to military firing personnel in the field will be used to remove ice from the weapons.

e. Attempt to fire with the exposed ammunition. If functioning is unsatisfactory, attempt to fire a belt (or magazine) of ammunition conditioned at the temperature (6 hours) but not subjected to icing.

f. If the weapon cannot be charged to initiate firing, due to the ice accumulation on the weapon, repeat the test by fully loading each weapon before exposing to icing. Guns firing from a closed bolt are readied for icing by closing the bolt on a chambered round; guns firing from the open-bolt position are readied by leaving the chamber empty and the bolt in the seared position. If the weapon fails to function properly, replace the belt (or magazine) with ammunition conditioned at the temperature (6 hours) but not subjected to icing.

4.5.7.2 Data Required. Record the following:

a. Test temperatures
b. Glaze accumulation
c. Number of rounds fired

d. Malfunctions in accordance with paragraph 5

e. Cleaning and maintenance performed to attain proper weapon performance.

4.5.8 Salt Water Immersion Test (10-day). This subtest determines deleterious effects of salt water on weapon performance.

4.5.8.1 Method.

a. Prepare a salt water solution of 5% sodium chloride and 95% water by weight. The sodium chloride must not contain more than 0.1% sodium iodide and 0.2% other impurities.

b. Prepare three test weapons in accordance with the maintenance literature. The weapons will not be over-lubricated to discourage corrosive buildup. Weapons with adjustable gas systems will be set on minimum but adjusted to maximum if necessary.

c. Temperature-stabilize the weapons, ammunition sufficient to fire at least four reloadings on each of 5 days, and the salt water solution to within 20° C of each other before immersing.

d. Fully load a weapon and place its safety "on". Immerse the loaded weapon and all of its ammunition (in their appropriate belts, magazines, chargers, or clips) in the salt water solution for one minute. The solution must cover the test items completely.

e. Remove the test item, and drain all salt water from the bore by depressing the weapon muzzle and slightly retracting the bolt to allow the salt water to drain from it (salt water is similarly drained from the bore of a weapon that fires from the open-bolt position but without disturbing the bolt). Fire the weapon as follows:

1.	Single-shot only	All rounds
2.	Semiautomatic only	All rounds
3.	Semiautomatic, controlled length automatic burst	50% each mode
4.	SA, CB, fully automatic burst*	At least one load complement per mode; extra rounds to be fired in FA mode
5.	FA*	All rounds

*All weapons having an FA mode will also be fired in short bursts for a loading increment.

f. Repeat d and e with the other two weapons.

g. Repeat firing with all three weapons on days 3, 5, 8, 10. If conditioned ammunition and/or magazines, etc., prevent weapon functioning, substitute clean ammunition and/or magazines from that point on in the 10-day test. No cleaning, wiping, or maintenance of the weapons is permitted until after the test has been completed or until such time as they are rendered inoperable. Should

this occur before 10 days, perform the minimum restorative maintenance necessary to return each weapon to operating condition, and continue testing to its normal conclusion. Store the weapons and ammunition in a high humidity environment (at least 90% RH) when not being fired or immersed.

h. Photograph the test item as necessary.

4.5.8.2 Data Required. Record the following:

a. Number of rounds fired
b. Cyclic rate of automatic fire
c. Test temperatures and weapon exposure times
d. Malfunctions in accordance with paragraph 5
e. Maintenance data

4.6 Unlubricated Test. This subtest determines whether the test item will function in an unlubricated condition.

4.6.1 Method.

a. Remove all lubrication (except dry film lubricant applied at time of manufacture) to all parts of three weapons to be tested.

b. Fire at least 1,000 rounds of ammunition using an endurance test firing schedule (see paragraph 4.3 for discussion of possible firing combinations).

c. No weapons or ammunition will be lubricated until the weapon is rendered inoperable by the test environment. If this occurs, perform minimum restorative maintenance necessary to return the gun to operating condition, and resume firing.

d. Guns with adjustable gas systems are set at "minimum" until problems dictate a change. Firing will be with each progressive adjustment available until either the gun operates properly or the maximum power setting has been used.

4.6.2 Data Required. Record the following:

a. Number of rounds fired
b. Firing modes and sequence
c. Cyclic rate of automatic fire
d. Malfunctions in accordance with paragraph 5
e. Maintenance data, including effects of propellant fouling

4.7 Fouling Test (5-day). This subtest determines the effects of combustion residue buildup on weapon performance.

4.7.1 Method.

a. Maintain the three test weapons in accordance with the maintenance literature for a temperature of -7° C.

b. Condition the weapons, ammunition (at least 1,000 rounds per weapon), and magazines in the environmental facility at -7° C for at least 12 hours before initiating firing.

c. The quantity of ammunition per weapon is equally divided into fifths. One-half of each day's allocation is fired in the morning, and the remainder in the afternoon (4-hour intervals between firings). Use the firing schedule appropriate for the weapon being tested (see Table 4).

d. No maintenance takes place during this test unless a weapon is rendered inoperable by the test environment. If this occurs, perform minimum restorative maintenance, and continue testing until completed. Do not remove the weapon from the test environment to perform maintenance.

4.7.2 Data Required. Record the following:

a. Number of rounds fired and the date
b. Mode of fire
c. Cyclic rate for all automatic bursts fired
d. Malfunctions in accordance with paragraph 5
e. Maintenance data

4.8 Sustained Fire Test. This subtest determines the maximum rate and duration of firing that can be accomplished without damaging the weapon, degrading its performance, or endangering the person firing.

4.8.1 Method.

a. Disassemble, thoroughly clean, lubricate, and reassemble at least three test weapons.

b. From a bench rest, fire semiautomatically 10 shots at each of three targets at a range of 100 m with each test weapon. NOTE: Throughout this test, weapons without semiautomatic fire capability are fired in 3- to 5-round bursts. Weapons without automatic fire capability are tested only in the semiautomatic mode. Firing of a control weapon will be similar to that of the test weapon.

c. Measure and record the x and y coordinates of the projectile impacts on each 10-round target and at least 10 projectile velocities for each test weapon.

d. Fire each test weapon semiautomatically at a rate of 15 rounds per minute for 30 minutes. Completely cool the weapon, and then fire 40 rounds per minute for 5 minutes.

e. Measure and record the projectile yaw and velocities for the first and last magazines of each phase. The requirements for the projectile yaw target are contained in TOP/MTP 4-2-604.[16]

f. Repeat the procedure (b through e above) with each test weapon in the automatic mode of fire. Record cyclic rates of fire for all automatic firing modes.

g. Disassemble, thoroughly clean, lubricate, and reassemble each test weapon.

h. Repeat steps b through g above with the rates of fire in d doubled and the firing time halved. Photograph the weapon during firing of the final magazine.

i. Repeat step h, but with the rates of fire (in h) doubled and the firing time halved.

j. Immediately after the conclusion of each 450- and 200-round cycle, chamber a single round and time it for the possibility of a cookoff (paragraph 4.3). If cookoff does not occur, fire the round. The yaw target should be remotely changed so that the projectile signature from the high-temperature-conditioned round can be examined.

4.8.2 Data Required. Record the following:

a. X and y coordinates of each impact
b. Projectile velocity
c. Mode of fire
d. Cyclic rate of automatic fire
e. Yaw data in accordance with TOP 4-2-604.

4.9 Flash Test. Since muzzle and breech flash created by firing can reveal the firing position to the enemy, the flash test is conducted to determine the amount of flash characteristic to each weapon.

4.9.1 Hand Guns and Shoulder Weapons.

4.9.1.1 Method.

a. Disassemble, clean, lubricate with prescribed oil, and reassemble two test weapons. One weapon should be new and the other used, the latter being a weapon previously fired to approximate its service life.

b. Fabricate a reference flash scale as illustrated in Figure 1 and mount the scale parallel to the barrel at the muzzle of the test weapon.

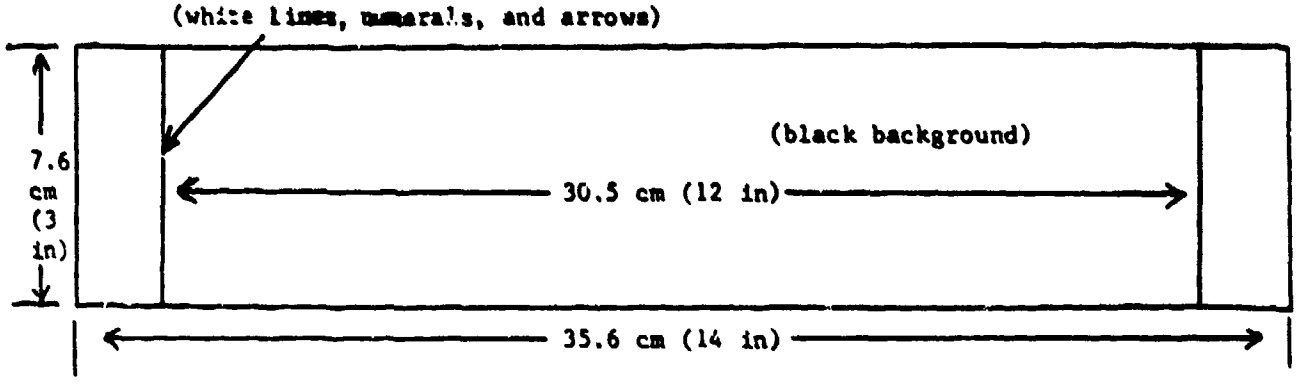

Figure 1. Reference scale dimensions.

c. X-ray the muzzle devices of all test weapons immediately before each muzzle flash test to ascertain to what extent the interior of the muzzle device may be contaminated by fouling. This may be especially desirable when two or more weapon types are contending.

d. Mount a 10.2- by 12.7-cm (4- by 5-in.) camera with a lens opening of F2.5, using film with an ASA 250 rating, perpendicular to the muzzle of the test weapon at a sufficient distance to photograph all of the flash, but no closer than 1.4 m (4.5 ft).

e. Photograph the scale mounted in step b to establish a film scale for subsequent photographic records of flash.

f. Photograph the cumulative flash from 20 rounds* fired semiautomatically under completely darkened conditions. Use a shielded flashlight to lightly illuminate the weapon muzzle before each flash firing.

g. Repeat step f, photographing the cumulative flash from a 20-round* burst fired automatically.

h. Annotate the photographs of cumulative flash with regard to flash variations during the burst firing. NOTE: Depending on test objectives, the flash test may be repeated with various types and lots of ammunition.

*Or whatever the magazine capacity; however, if two candidate weapons are competing, both weapons will be fired with the same number of rounds as the least magazine complement.

4.9.1.2 Data Required. Obtain photographic records of the reference scale and flash events. Photographs of cumulative flash should be supplemented by visual observations regarding flash variation during firing.

4.9.2 Machineguns and Automatic Weapons.

4.9.2.1 Method.

a. Conduct as stipulated in 4.9.1.1.a, b, c, d, and e.

b. Photograph cumulative muzzle and breech flash occurring during a 20-round burst with a still camera under completely darkened conditions and compare the photographs with those of flash from a standard weapon obtained under the same circumstances.

c. Fire new and old barrels cold and hot (see below). Before firing a cold barrel, fire one round to remove any oil that may be in the bore. Then fire a 20-round burst for flash. For the hot-barrel phase, fire 260 rounds in 20-round bursts at the rate of 85 rounds per minute. Then immediately fire a 20-round burst for flash. Fire a standard weapon and photograph for comparison.

Barrel Definitions

New barrel - one having 90% or more life remaining
Old barrel - one having 40% or less life remaining
Cold barrel - one conditioned at normal ambient temperature
Hot barrel - one having an external surface temperature of about 450° C at a point just ahead of the neck area of the chamber

d. As in 4.9.1.1.h, annotate the photographs of cumulative flash with regard to flash variations during burst firings. NOTE: Depending on test objectives, the flash test may be repeated with various types and lots of ammunition.

4.9.2.2 Data Required. Record data as described in 4.9.1.2.

4.10 Smoke Test.

4.10.1 Method. The smoke cloud accumulated at the gun during burst fire is evaluated from the standpoints of target obscuration when viewed from directly behind the gun and visibility (or signature) of the cloud from a distance beyond the muzzle. The firings are conducted in an open area without shadows in the areas being photographed when visibility is suitable for obtaining a sharply defined photograph under nonfiring conditions.

For both smoke tests, use a 35-mm camera with a remotely operated motor drive set for four frames per second with an 80- to 200-mm "zoom" lens (or equivalent) attached and a film with an ASA 400 rating or equivalent. A standard control weapon of equivalent caliber of the test weapon(s) is fired for comparison purposes. Conduct firings when the wind is zero, and record air temperature and humidity.

a. Target Obscuration. Fire a 20-round burst (or one magazine for hand and shoulder weapons and a 25-round burst for machineguns and automatic weapons) from each weapon to establish the degree of target obscuration for comparison between the control weapon and the test weapons. To judge the size and density of the smoke cloud and the degree of obscuration, use a checkerboard target 2.4 m square with 0.3-m black and white squares placed in line with the weapon at a range of 100 m. Elevate the weapon to fire slightly above the target. Photograph the target with the camera running at four frames per second before and during the burst. Place the camera behind and as near as practical to the weapon in the position assumed by the gunner to clearly focus on the front sight or muzzle and the target.

b. Smoke Cloud or Signature of the Weapon. Photograph the smoke cloud produced by a 20-round burst (or one magazine for hand and shoulder weapons and a 25-round burst for machineguns and automatic weapons) against a black background before and during firing of the burst. Use the same camera setup positioned 30 m beyond the muzzle and 4 m to the right of the line of fire.

4.10.2 Data Required. Obtain photographic records of smoke cloud formation. NOTE: The test plan should state the number of weapons and rounds in a burst that are compatible with the particular weapons being tested.

4.11 Noise Test. Test according to TOP 1-2-608.[17]

4.12 Rough Handling Test.

4.12.1 Weapon Test.

4.12.1.1 Method. Subject the weapons to a sequence of rough handling tests in accordance with TOP 4-2-602.[18] These tests usually consist of packaged drops from 2.1 m (7 ft), a loose cargo test in the unpackaged configuration, and unpackaged 1.5-m (5-ft) drops. The loose cargo and 5-ft drop test should be performed with a primed but otherwise inert cartridge(s) to assess the possibility of accidental firing. Following the rough handling, inspect and fire the weapons to verify safety and operability. They must not show any apparent change in accuracy or frequency of malfunctions and must require no more than first echelon maintenance (the rifleman's) to correct any damage.

4.12.1.2 Data Required. Collect data in accordance with TOP 4-2-602.

4.12.2 Mount Test.

4.12.2.1 Method.

To determine the ability of the adaption components and mounts to withstand rough handling, the mounts are tossed and dropped to land on firm sod. Efforts are made to have the mount impact equally on all ground-seating points.

a. Set and lock all legs on each mount in the open position.

b. Toss each mount, without the weapon attached, about 1.8 m (6 ft) from a 0.9-m (3-ft) height 50 times (25 times with and 25 times without the adapter), unless failure occurs earlier.

c. After every five tosses, examine the mounts for damage.

d. Drop each mount, with adapter and weapon attached, straight down from a 0.9-m height to land on firm sod a total of three times.

e. After each drop, examine the mount for damage.

4.12.2.2 Data Required. Record data as obtained above.

4.13 Attitudes Test. This test is designed to determine the functioning and reliability performance of machineguns and automatic weapons when fixed to a gimbals type mount and fired in various orientations and attitudes.

4.13.1 Method. Firing is conducted in four stages: 1) gun top side up; 2) gun right side up; 3) gun left side up; and 4) gun upside down. For each stage, 12 100-round cycles are fired with 50-round belts (or equivalent magazine) in the sequence shown in Table 14. When testing weapons with a dual rate of fire, fire the 50-round belts alternately at high and low rates. If the test weapon is capable of more than two rates, fire 25-round complements at each rate.

TABLE 15

TEST SEQUENCES FOR ATTITUDE TESTS

Elevation	Burst Length	Feed
0°	Sporadic 5-round bursts	When designed for
0°	Continuous[a]	left- and right-
Max depression[b]	Sporadic	hand feeding,
Max depression	Continuous	entire sequence
Max elevation[c]	Sporadic	is fired at
Max elevation	Continuous	each feed.

[a]If the weapon has semiautomatic capability, continuous bursts are alternated with semiautomatic fire.
[b]Maximum depression -85° to -90°
[c]Maximum elevation +85° to +90°

4.13.2 Data Required. Record the following:

a. Number of rounds fired
b. Malfunctions in accordance with paragraph 5
c. Cyclic rates of fire

4.14 Belt Pull Capacity.

4.14.1 Method.

a. Determine the maximum belt pull for left- and right-hand feeding of machineguns and automatic weapons (if alternate feed is provided) by using a 10-round belt of ammunition and three dummy rounds. A cable is attached to the third dummy round; an antisurge spring is used between the other end of the cable and a transducer (strain gage load cell or spring scale) which is fixed to a rigid mounting point.

b. Base selection of the antisurge spring(s) on the feeding characteristics of the test weapon. The spring must be long enough to permit gradual load application leading ultimately to stalling of the gun due to excessive belt load. The rate of the spring(s) before being deflected is less than the belt pull capacity of the weapon, and when stressed, is greater than the capacity of the weapon without exceeding the elastic limit of the spring(s).

c. Use a low-friction ammunition guide tray to support the ammunition. The tray is open at the top so that the rounds (or feed chuting if required) are not restricted in upward motion. The sides of the tray should fit the rounds or feed chuting closely enough to limit the motion of the rounds along their longitudinal axis.

d. Fire the weapon in a continuous burst until it stops, and record the load cell output with a type 5-124 recording oscillograph.

4.14.2 Data Required. Record the belt pull capacity of the weapon (i.e., lb of pull exerted and recorded on the oscillograph when the gun stops, regardless of the number of rounds fired). At least three trials are fired to confirm the results.

4.15 Acceleration. Since any machinegun or automatic gun is likely to be used on a ground vehicle, helicopter, or fixed wing aircraft, an abbreviated acceleration test is conducted to determine whether the weapon will function and feed ammunition satisfactorily while subjected to gravitational forces. Such forces vary from 2 g's in a helicopter to as much as 8 g's in ground vehicles.

4.15.1 Method. To conduct an acceleration test, a centrifuge facility is required. The weapon and a small amount of ammunition (10 to 20 rounds) for each firing trial are mounted (vertically, muzzle down) on the arm of a centrifuge, and rotated until the desired g level is obtained. From a remote observation point, attempts are made to fire the weapon for evaluation of its functional capability under acceleration loads of 4 and 10 g's. The trials are also conducted with the gun mounted in its four major axes: top, bottom, left, and right about its longitudinal axis. During the test, electronic instrumentation is employed to determine rates of fire, electrical power needed to function the weapon, sequence of the firing functions, and any malfunctions. NOTE: A centrifuge facility that can accommodate weapon acceleration testing is located at Patuxent River Naval Air Station, Maryland.

4.15.2 Data Required. Record the following:

a. Number of rounds fired
b. Malfunctions in accordance with paragraph 5
c. Cyclic rates of fire

4.16 Barrel Performance.

4.16.1 Method. In evaluating barrel performance of machineguns and automatic weapons, determine the following: burst average velocities, shot/dispersion patterns, yaw of each projectile in flight, cyclic rate of fire of the gun, and barrel erosion.

a. Take stargage measurements and inspect the bore with a borescope before firing to ascertain that the barrels conform to drawing specifications.

b. Test at least five barrels on each firing schedule (as determined by the user, usually from a tactical situation) to establish bore life. All planned test schedules should be conducted with one lot of ammunition. If more than five barrels are available per firing schedule, however, additional ammunition lots (containing different propellant lots) should be selected for evaluation of different erosion characteristics.

c. A barrel is considered unserviceable when:

(1) Twenty percent or more of any 40 consecutive rounds in a burst (or 20% of any burst less than 40 rounds) exhibit yaw of 15° or more, or

(2) The mean velocity of any 20 consecutive rounds in a burst drop 61 m/s (200 fps) or more below the mean velocity of the first 20 rounds fired.

d. Measure the full length of the bore with a bore wear gage before firing, each time a barrel is completely cooled, and after the barrel reaches unserviceability. In this way, correlation between barrel wear and unserviceability can be established and can be used for calibrating a gage for determining life of barrels in the field. Every effort should be made to avoid firing schedule interruptions during barrel erosion tests so that valid bore life results can be obtained. Stoppages or other delays during the initial stages of a firing cycle can be disregarded; any delays during periods when critical barrel temperatures are reached, however, will significantly change barrel life, thereby disqualifying the results. In such instances, the barrel test should be discontinued, and the life of a replacement barrel should be determined. Generally, the only completely valid barrel performance data are obtained from stoppage-free barrels, and every effort should be directed toward that end.

4.16.2 Data Required. Record the following:

a. Data as obtained above

b. Additionally, during barrel performance firings which involve sustained rigorous firing schedules, observations will be made of the adverse effects of high weapon temperatures on the gas system, recoil booster, components (expanded and binding), etc. The effects of lubricant dissipation and combustion residue buildup (including moisture, carbon, copper, etc.) will also be evaluated.

4.17 Human Factors Evaluation. Throughout all test operations, observe and record data related to the effectiveness with which the test system is deployed, operated, and maintained by representative users and the degree to which it is compatible with the capabilities and limitations of individual operators. Restrictions imposed by individual body size and build, clothing and body armor, effects of noise level (see paragraph 4.11), ease of loading and firing in various positions, tendency of the weapon to "ride up", recoil effect, etc., are typical areas of concern. Evaluate the adequacy of human factors engineering of the test system using appropriate data-collection aids (task lists, performance checklists, error reports, interview forms, rating scales, etc.) prepared or selected from the following guides:

a. TOP 1-2-610, Human Factors Engineering, Part I, Test Procedures, 20 December 1977, and Part II, HEDGE, Human Factors Engineering Data Guide for Evaluation, US Army Test and Evaluation Command, December 1977.

b. MIL-STD-1472A, Human Engineering Design Criteria for Military Systems, Equipment and Facilities, May 1970.

c. MIL-HDBK-759A, Human Factors Engineering Design for Army Materiel.

4.17.1 Method. Determine, report, and evaluate as appropriate:

a. Configuration and operation of weapon and mount controls (grips, triggers, sights, charging handle, elevating and traversing knobs, locking handles, mounting pins and lugs, etc.)

b. Time required for:

(1) Conversion from fixed to flexible role
(2) Assembly to, and removal from, ground mount
(3) Extra operations in weapon assembly or disassembly attributable to addition of components for flexible use

c. Facility with which the following can be performed:

(1) Traverse
(2) Elevation (at maximum and minimum limits)
(3) Sight adjustment and reading
(4) Battle sight setting under poor visibility

d. Physical measurement of:

(1) Recoil energy
(2) Trigger pull force and smoothness
(3) Balance point of weapon and balance in regard to grips, handles, and carrying devices

e. Observational evaluation of:

(1) Compatibility in the left-handed use
(2) Ease of carrying the weapon at the ready and stowed position during road marches and when negotiating various obstacles

f. Stability of system during manual charging, with and without sandbags; stability of the system is also noted throughout firing; accuracy results will be analyzed as described in paragraph 4.4.

4.18 Logistic Supportability. Throughout the test, collect data to determine the maintenance characteristics of the test item in accordance with TECOM Suppl 1 to DARCOM-R 700-15.[19] Use appropriate forms contained in TECOM Suppl 1 (i.e., maintenance and parts analysis charts, etc.) to record the performance of all organizational, direct and general support maintenance tasks to determine, if applicable, the adequacy of the following items and to provide data for the preparation of maintainability indices:

a. Tools and test, measurement, and diagnostic equipment (TMDE)
b. Equipment publications
c. Repair parts
d. Safety aspects of maintenance operations
e. Human factors aspects of maintenance operations
f. Design for maintainability
g. Transportation, packaging, and handling

Document each test incident by Equipment Performance Report (EPR) in accordance with DARCOM-R 70-13.[20]

4.19 Reliability. To determine whether or not an item meets the reliability criteria stated in the requirements documents, use data collected during endurance testing, during those test phases that are not interspersed with extreme severity tests, and during any special maintenance evaluation tests. If

additional data are needed for mean rounds between failure, additional firing may be performed with weapons that have not reached their design life. Additional firing would consist of 100-round cycles (or as specified in the requirements document) conducted in the same manner as the endurance test. Three weapons, each fired 6,000 rounds, may be necessary. Additional guidance on statistical samples can be found in TOP/MTP 3-1-002.

4.20 Post-Firing Inspection. At the completion of each test of each weapon, the components should be inspected to determine if cracks have developed. Magnetic particle inspection is appropriate.

5. DATA REQUIRED. The purpose of recording data is to establish an accurate, complete historic profile of the items being evaluated. For some tests, the definitions listed in Table 16 are sufficient to explain what has occurred; in other tests, failure definitions and scoring criteria specified by the customer take precedence whenever these criteria conflict with those in Table 16.

The advent of increased data computerization from input through completed analysis may change the format and content of the information presented here. Therefore, this information is mainly for use as a guide in planning the appropriate data-collection and analysis portion of the test plan.

The cycle of operation of most small arms weapons, from pistols and revolvers to heavy machineguns, is broken down into six parameters: feeding, chambering, locking, firing, extracting, and ejecting (in that order). Within these six parameters, malfunctions may occur which can adversely influence one or more segments of RAM (reliability, availability, maintainability) while still permitting continuation of firing. Other malfunctions, referred to as stoppages, immediately prevent further firing until corrected. In recent years, the trend has been to include malfunctions of either type under a maintenance category, since a malfunction or a stoppage requires some action in order to correct the problem.

Data collection for large, complex development programs is usually controlled by a RAM-D Failure Definition and Scoring Criteria manual published jointly by the materiel and combat developers. The format and content of that document are established by AR 702-3[21] and the test item's specification or other qualifying publications. Since the RAM-D Failure Definition and Scoring Criteria address analysis of the collected data rather than specific nomenclature of the stoppages and other malfunctions, the definitions explained in Table 16 are used as the basis for describing what has occurred. Then, the definitions shown in the RAM-D Failure Definition and Scoring Criteria are applied.

When test programs do not use a RAM-D Failure Definition and Scoring Criteria list, data collection and analysis should be tailored to meet the specific needs of the program. The basic concepts previously discussed should still be used. In this manner, if a scoring conference should be necessary to clarify disputed data, a concise, presentable format will have already been prepared and used.

In testing weapons, the primary method of reporting where an incident occurs is by using round counts. Several types are used, including cumulative total rounds on the weapon receiver or frame. Within this end item, major components can require their own round counts (e.g., quick-change barrels, multi-directional feed mechanisms, and magazines). Attachments to the end item, as well as parts

rendered unserviceable or damaged/worn due to use, may also require separate round tallies.

After establishing an appropriate format for recording round counts, provide the other types of data collected and reported on the data sheet. These include identification of the test item, ammunition used, project engineer's I.D., subtest title, test phase and/or firing cycle, mode of fire, number of rounds loaded in the belt, magazine, clip, etc., number of rounds fired from that load complement, and the total cumulative rounds fired to-date from that weapon.

Malfunction. A malfunction is a faulty action of the ammunition, weapon, or supporting equipment. Malfunctions are divided into two categories: those that cause stoppages (unintended interruptions of firing) and those that do not. Examples of malfunctions that cause stoppages are weapon failure to feed, extract, or eject. These may or may not be caused by a part failure. Examples of malfunctions that do not cause stoppages are damaged weapon sear or solenoid components that cause uncontrolled fire; loss of weapon flash suppressor; and loosening and shifting of a sight.

In performance-type tests, attempts are made to determine the cause of each malfunction and whether the fault is attributable to the gun, magazine, or ammunition belt (link), ammunition, installation (supporting equipment), or personnel. A special category termed "repetitive" is used when repeated stoppages due to a faulty component occur, and corrective action is not immediately determined or incorrect action is taken. For example, if a series of identical gun stoppages occurs and the first stoppage is attributed to the gun because of a faulty gun component, the three identical stoppages that follow are charged as repetitive, assuming that the fault was correctable after the first occurrence. When repetitive malfunctions occur due to faulty gun design rather than component failure and immediate action by the gunner is not possible, each such stoppage is charged to the gun instead of repetitive. Malfunctions attributable to otherwise improper personnel action such as faulty component assembly or improper loading of ammunition are charged to personnel.

Data obtained during performance tests should be used when feasible in the maintenance evaluation of an item, but it is essential that the determination of malfunction cause(s) not be compromised in these tests to concurrently obtain data for the maintenance evaluation.

When a malfunction occurs, the mode of fire (if different from that specified in the firing schedule) is noted, along with the type of malfunction (use one of the six in Table 16). If more information is needed to clarify a "non-standard" type of malfunction, use the narrative form and write it immediately following the basic malfunction-type assessment. Since RAM data must be obtained concurrently during testing (in most cases), this information is also noted in the firing data log and supplemented by a separate maintenance log when necessary.

TABLE 16

DESCRIPTION AND PROBABLE CAUSES

FFD Failure to feed:
- BOB - bolt override of cartridge base
- BUR - bolt underride of cartridge base
- SR - short recoil of components
- FFO - failure to feed over (belted ammo)
- DF - double feed

FTC Failure to chamber:
- FS - failure to strip round (from magazine, clip, or link)

FTL Failure to lock:
- BLE - bolt lacked energy to close (weak drive spring)

FFR Failure to fire:
- FTR - failure of trigger to return forward
- FSO - failure to sear off

FEX Failure to extract:

FEJ Failure to eject:
- SB - spinback of case/cartridge into ejection port

Other symptoms:
- FRA - failure to remain in assembly
- FBR - failure of bolt to remain to rear (weapons equipped with last round bolt stops)

Classification of test incidents in accordance with MIL-STD 882A[22] and TOP 1-1-012[23] for hazard level determination is also necessary.

If no RAM-D Failure Definition and Scoring Criteria are available for use in determining the classification of malfunctions, develop a time-based classification from available operational performance requirements documents, or use Table 17.

TABLE 17

CLASSIFICATION OF MALFUNCTIONS

Class I	Class II	Class III	Class IV
Clearable within 10 seconds	Clearing takes more than 10 seconds	Requires part replacement available to gunner	Requires part replacement not available to gunner

Using this type of information will assist in completing RAM analysis. The final type of standard report requiring data input is the equipment performance report (EPR), DARCOM Form No. 2134, which requires a description of the end item and/or part and classification of the incident in one of three categories: critical, major, or minor, or reported for information only. Guidance in categorizing incidents can be found in DARCOM-R 700-38.

The data collected should substantiate classification of the incident reported.

6. DATA PRESENTATION. Test results are analyzed by suitable statistical procedures for comparing samples, for obtaining point or interval estimates of a parameter, and for determining from test results whether specific requirements have been satisfied. TOP/MTP 3-1-002 provides guidance on analyzing and presenting test results.

Recommended changes of this publication should be forwarded to Commander, US Army Test and Evaluation Command, ATTN: DRSTE-AD-M, Aberdeen Proving Ground, Md. 21005. Technical information may be obtained from the preparing activity: Commander, US Army Aberdeen Proving Ground, ATTN: STEAP-MT-M, Aberdeen Proving Ground, Md 21005. Additional copies are available from the Defense Technical Information Center Cameron Station, Alexandria, Va. 22314. This document is identified by the accession number (AD No.), printed on the first page.

APPENDIX A
SAND AND DUST FACILITIES

A variable speed blower with volumetric dry feeder attached is mounted outside the test chamber. The feeder must deliver a constant but adjustable flow of dust mixture to the air-delivery pipe of the blower. The blower-feeder combination must be capable of dispensing sand and dust so that the mixture falls evenly on the area concerned at a rate of 100 $\pm$25 g/min/m^2.

Two types of chambers may be used for the sand and dust test, as follows.

Type A. This type is used for standardized testing (NATO, some specifications) of smaller weapons. The test chamber is a box made of 25-mm (1-in.) plywood 0.9 m (3 ft) wide, 1.2 m (4 ft) high, and 1.8 m (4.5 ft) long, with transparent sides and an interior gun cradle. A 7.6-cm (3-in.) vent hole aligned with the blower is in the end of the box opposite the blower. A pair of rubber gauntlet gloves for the gunner is attached over hand openings on each side of the box. The gloves provide dust-sealed access to the gun and permit full control of the weapon, including installing magazines and firing.

Type B. This type of chamber is used for larger weapons or when it is not convenient to use type A. This chamber consists of a box of any size that allows free circulation of the sand- and dust-laden atmosphere around the weapon. The chamber is provided with vents to relieve any buildup of air pressure, and aid in circulating the dust. It may be bottomless so that it can be placed over the weapon. Access doors and ports are provided as needed but must fit closely enough to contain the circulating atmosphere. NOTE: The dust-laden atmosphere should not be breathed by personnel. Do not allow anyone to enter the chamber without approved breathing protection or unless the chamber is first purged of any visible dust.

APPENDIX B
REFERENCES

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2. TOP/MTP 3-1-002, Confidence Intervals and Sample Size, 25 January 1967.

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5. TOP 3-2-504, Safety Evaluation of Hand and Shoulder Weapons, 1 March 1977.

6. AR 385-63, Safety Policies and Procedures for Firing Ammunition for Training, Target Practice, and Combat, 1 April 1978.

7. DARCOM Reg 385-100, Safety Manual, 17 August 1981.

8. APG-MT-5698, Small-Caliber Weapon Cookoff Testing, D.E. Phillips, October 1982.

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13. DPS-1692, Final Report of Study to Determine High-Temperature Test Procedures for Selected Infantry Weapons to Satisfy AR 705-15, October 1965.

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16. TOP 4-2-604, Range Firings of Small Arms Ammunition, 8 February 1971.

17. TOP 1-2-608, Sound Level Measurements, 17 July 1981.

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